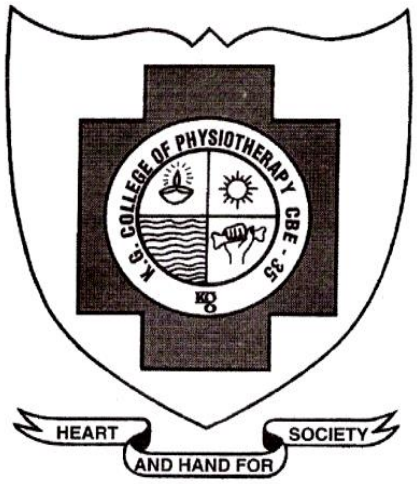
# "AN EXPERIMENTAL STUDY TO ANALYZE THE EFFECTIVENESS OF CROSS ECCENTRIC QUADRICEPS STRENGTH TRAINING ON FUNCTIONAL DISABILITY IN COLLEGIATE FOOTBALL PLAYERS WITH ACL RECONSTRUCTION"

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**ELECTIVE: PHYSIOTHERAPY IN SPORTS**

**A DISSERTATION SUBMITTED TO THE TAMILNADU**

**Dr. M. G. R MEDICAL UNIVERSITY, CHENNAI.**

**AS PARTIAL FULFILLMENT OF THE**

**MASTER OF PHYSIOTHERAPY DEGREE**

**APRIL 2016.**

# CERTIFICATE

Certified that this is the bonafide work of **Mr. B. Sachin murali** of K. G. College of Physiotherapy, Coimbatore submitted in partial fulfillment of the requirements for Master of Physiotherapy Degree course from the Tamil Nadu Dr. M. G. R Medical University under the **Registration No: 271450141**for the April 2016 Examination.

Date: Principal

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**Has been submitted in partial fulfillment for the requirement of the**

**Master of Physiotherapy degree,**

**April 2016.**

Internal examiner External examiner

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## CONTENT

# I. INTRODUCTION

The Anterior cruciate ligament injuries are more prone to occur in sports like football, volleyball, basketball, hockey, kabbaddi etc., More than 70% of these occur through non-contact activities, while 30% due to direct impacts during gaming. The injury happens while decelerating during cutting, twisting, moving to side and improper landing. Nearly 50% of ACL injuries involve damage to meniscus and articular cartilage and other ligaments **Griffin LY et al., 2000.**

The most commonly occurring ligament injury in knee joint is anterior cruciate ligament, which accounts for a significant functional impairment. The ruptured ACL is surgically reconstructed using autogenous grafts, which can affect an individual's early return to sporting activities **Goh s et al., Boyle J et al., 1997.**

The recent advances in ACL rehabilitation are focusing on aggressive restoration of range of motion and strength, with an accelerated protocol for early return to sporting activities within 4-6 months after surgery. Maintaining cardio-vascular conditioning, proprioception and muscular co-ordination with appropriate exercises are focused in ACL rehabilitation **D'amato M et al., Bach BR et al., 2003.**

Many ACL reconstructed patients have weakness of muscle even after the rehabilitation, and more specifically weakness of quadriceps is seen in patients, experiencing poor functional abilities **Williams GN et al., Buchanan TS et al., Snyder-Mackler L et al., Barrance PJ et al., 2005**.

The quadriceps weakness is more pronounced in the early postoperative period **Mchuge et al., 2002**. The ACL graft had to be protected in the early post-operative phase, as more intensive rehabilitation protocols are contraindicated **majima et al., 2002, Wilk et al., 2003**.

The central nervous system and knee joint works together for the complex kinematics of both mechanical stability and dynamic interaction of the joint. About 1% to 2% of mechanoreceptors rupture in ACL injury affecting proprioception **Schultz RA et al., Miller DC et al.,** The rupture of ACL not only affects the performance of a player but also his joint position sense with anterolateral instability of knee **Noyes et al., 1991**. The ACL deficiency causes poor rotational stability, meniscal injury and early degeneration of the joint.

This joint instability happens due to inhibition of mechanoreceptor's neuromuscular reflex, producing repetitive injuries and diminishes muscles response for providing joint stability **SM Lephart et al., 1995**.

**ZHOU et al., 2000** states that training of one limb improves strength in the contralateral untrained limb, known as the cross education, cross training or

cross transfer effect. When muscle contracts voluntarily on the trained leg, it facilitates the cerebral cortex's opposite side motor point of the same muscle, thus eliciting its activity.

The joint immobilization after ACL reconstruction causes decreased range of motion, muscle atrophy and poor flexibility. Isometric exercises are performed in the injured leg to prevent this negative effect **Seki K et al., 2007.** But the pain in the operated leg has limitations. Cross training or contralateral training is used to improve strength, endurance and skills of contralateral limb by training the other limb, which is known as cross education or contralateral transfer or bilateral transfer. Many studies have found that contralateral transfer is due to certain changes in the neural activity **Cook TW et al., 1993, Caroll TJ et al., 2006.**

**Jones et al., and Rutherford et al., 1987** states that isotonic contraction exercises improved untrained limb strength than the isometric exercises **Hortobagyi T et al., 1997** found that there is more bilateral transfer, during the eccentric type of muscle contractions than during concentric type of muscle contractions.

Based on the previous studies, adding cross eccentric exercise to the ACL rehabilitation program could be effective in enhancing the early restoration of quadriceps strength on the operated knee and range of motion.

## Incidence and Epidemiology

**Young sul yoon et al., 2004,** examined the incidence of football injuries in Asian tournament and concluded that around 18.5% injuries are prone to happen in knee joint and more serious injuries were related to ligament sprains and strains of thigh and back muscles. Further the injuries in Asian football players were higher than European players, however the mechanism of injury remained similar.

Football is world's biggest team sport and in recent year 2007, more than 207 associations affiliated to FIFA- Federation Of International Football. Playing football involves running, slopping, twisting, jumping, kicking and turning movements that places the players to a greater risk of injury. The injury risk is almost between 65-91% in male elite players and between 48-70% in female elite players and almost 70-93% of injuries affect the lower extremity in male players. ACL is one form of severe injury that could end a player's career and it's more common in football. A Swedish survey reported that 22% of players quit football because of injury.

The intrinsic risk factors like age, body composition etc., for injury is very rare when compared with the extrinsic risk factors like environment. The intrinsic risk factors include previous injury, inadequate rehabilitation, limb dominance, muscle imbalance, poor skills, high level of play and joint laxity for football injuries. The extrinsic risk factors include low training exposure,

training time for matches, improper warm-up, playing surface, playing position etc.,

The percentage of injury occurs during tackling is 24-27%, collision is 6-27%, sprinting 18-19%, shooting/kicking is 4-14% and cutting/turning is 6-8%. Most of the football injuries occurring during tackling. **Martin hagglund et al., 2007.**

## 1.2 NEED FOR THE STUDY

ACL injury is more prone to happen in sports activities and hence there several advancements in the surgical techniques and rehabilitation protocols use. Early return to sports participations for the players is more focused in the past studies. The focus of the rehabilitation programs on ACL injuries are early restoration of knee range of motion, early mobilization, volitional control of knee joint, hyperextension restoration, gait training, and early full weight bearing etc., Accelerated rehabilitation protocols, closed and open kinetic chain exercise, hydrotherapy and modification in the surgical procedures by means of allografts, autografts or synthetic substitutes were studied on ACL injuries.

In sports, ACL injuries happens while decelerating during cutting, twisting, moving to side and improper landing in sports like football, basketball, volleyball, kabbaddi etc., However, there are only few studies that had been focusing on the functional disabilities before and after ACL reconstruction.

Similarly, the effect of cross eccentric exercise for the enhancement of quadriceps strength and the proprioceptive changes before and after ACL reconstructions has been less focused by the researchers and very few studies on players for early return to sports.

Hence, the need for this study is to analyze the effectiveness of cross eccentric quadriceps strength training on functional disability in collegiate football players with ACL reconstruction.

## 1.3 AIM OF THE STUDY

The aim of the study is to analyze the effectiveness of cross eccentric quadriceps strength training on functional disability in collegiate football players with ACL reconstruction.

## 1.4 OBJECTIVES OF THE STUDY

- To find out the effect of proprioceptive training along with standard ACL rehabilitation on functional disability in collegiate football players with ACL rehabilitation.
- To find out the effect of cross eccentric quadriceps strength training along with standard ACL rehabilitation on functional disability in collegiate football players with ACL rehabilitation.
- To compare the effect of proprioceptive training and cross eccentric quadriceps strength training on functional disability in collegiate football players with ACL rehabilitation.

## 1.5 HYPOTHESIS

**Null Hypothesis:**

There will be no significant difference between proprioceptive training and cross eccentric quadriceps strength training on functional disability in football players with ACL reconstruction.

**Alternate Hypothesis:**

There will be significant difference between proprioceptive training and cross eccentric quadriceps strength training on functional disability in football players with ACL reconstruction**.**

**KEYWORDS:**

Proprioceptive training.

Cross eccentric exercise.

Lysholm knee score.

Single leg hop test.

# II. REVIEW OF LITERATURE

## REVIEWS ON CROSS ECCENTRIC TRAINING

### Chadapa Boonyoung et al., 2010

States that Cross eccentric training performed at fast velocity had an effect on the untrained limb showed improved peak torque in concentric and eccentric strength of the untrained leg after 6 weeks of training. Factors like training protocol, frequency and duration of training, velocity of contraction etc., could affect contra lateral effect. However the strength gained on the trained leg improve strength of the untrained leg. The study done on 20 patients showed significant increase in both contraction type with change in peak torque. Hence stated that cross training could be specific to type of contraction.

### Maria G. Papandreou et al., 2007

Concluded that by training the uninjured knee, the strength of the injured knee's quadriceps muscle improves considerably, when the uninjured knee is strengthened at different knee angles relating to the levels of ACL strains. Thus, contralateral eccentric exercise is a useful mechanism and should be implicated for athletic training and for ACL rehabilitation.

**RD Herbert et al., 2003**

Did a meta-analysis and found the data to pool making clear that there is moderate increase in the contralateral strength in young, healthy individuals, on unilateral resistance training. 7.8% increase in the strength of the contralateral limb, was achieved as an effect of unilateral training, which was 35% of the effect of the ipsilateral side.

**Norihiroshima et al., 2002**

Concluded that there is alteration in the increased muscle strength during detraining, which was induced by the cross education, but the degree of alteration is subject-dependent. Similarly this muscular strength is increased by the effect of cross education can be explained using the mechanism of central neural factors, but not solely during detraining.

**Hellebrant FA et al., 1947**

Suggests that during unilateral training, the contralateral limb contracts to assist in stabilization. This states that the untrained limb is not unexercised. However, in most studies the training interventions are designed such that the activity in the untrained limb is minimized. Also there is bilateral demands on postural stabilizing muscles during unilateral training and these benefits are also associated to the contralateral side.

## REVIEWS ON PROPRIOCEPTION TRAINING

### Elanchezhian chinnavan et al., 2014

Concluded that the proprioceptive training improved athlete's functional activities than the standard non operative rehabilitation program consisting of knee strengthening, cardiovascular endurance, agility and sports specific skills. Hence, his study recommends proprioceptive training to be included in ACL rehabilitation in the acute stage.

### RL cooper et al., 2005

Study results provided that proprioceptive and balance training were improved in ACL deficient patients. The outcome measures showed improvement that were reported after proprioceptive and balance training, but there were no detrimental effects like joint laxity and strength on comparison with standard rehabilitation.

### Zattestrom et al., 2000

The study resulted that proprioceptive and balance training provided significant improvement in the strength of quadriceps and hamstring muscle in both the ACL deficient and ACL reconstructed knee patients on comparison with standard rehabilitation program.

**Ochi et al., 1999**

Performed a study on ACL ruptured knee using somatosensory evoked potential (SEP) and concluded that the patients showed low values for somatosensory evoked potential stating reduced proprioception of knee joint. The patients who received rehabilitation in the acute phase of ACL injury had less difficulty in walking. This indicates the proprioceptive change in the acute phase of ACL injury.

**Bosch U et al., 1992**

After ACL surgery, the proprioception recovered between 3 and 6 months and further recovery was shown after that period. Hence patient returning to normal activity should be allowed after this period, as proprioception deficit could end dangerous. Hence this time interval for graft healing and proprioceptive recovery should be considered before planning rehabilitation.

**REVIEWS ON LYSHOLM KNEE SCALE**

**Kocher et al., 2004**

The Lysholm knee scale is commonly used in surgical studies of chondral damage. However, it was originally designed to assess the knee related ligament injuries. The scale demonstrated reliability and construct validity showing acceptable psychometric properties.

**Robert G. Marx et al., 2001**

Determined a study for the reliability and validity of four knee rating scales that are commonly used in athletic injuries. All the four scales the lysholm knee scale, cincinnati scale, American academy of orthopaedic surgeons sports knee rating scale and the activities of daily living scale fulfilled the criteria for reliability, validity and responsiveness and proved acceptability for clinical use.

**Lysholm J et al., 1985**

The functional and physiological impairments after ACL injury can be measured by goniometer, pain scales etc., were as disabilities in daily activities, sports specific activities, were traditionally measured using valid scales like Lysholm knee scale and Cincinnati knee scores.

**Tegner Y et al., 1985**

The usabilty of lysholm knee scale in knee ligament, meniscal injuries, chondral injuries and patella dislocations are found reliable and researchers should use it in the same scale version.

**Gillquist J et al., 1982.**

The modified lysholm knee scale is a questionnaire of eight item, which is commonly used in ACL injury patients. The scale makes good reliability and construct validity, even though it is developed without patient inputs.

## REVIEWS ON SINGLE LEG HOP TEST

### Andrea Reid et al., 2007

Concluded that the four hop tests used as outcome measure for ACL reconstructed patients proved reliable and valid on performance basis. This result provide support to use the series of hop tests such as single leg hop test, 6m timed hop test, triple and cross over hop test in the clinical and research practice.

### Augustsson et al., 2006

Suggested that single leg hop test was more challenging as there is deceleration of body mass both horizontally and vertically, when landing from single leg hop and it is not as simple to perform functional exercises. Hence, single leg hop testing could be used to analyze the improvement in functional activity of the patients after training.

### Borsa PA et al., 1998

States that Hop tests can be used as potential tests to measure dynamic knee stability. Hop tests are most often used as an outcome measure based on the performance related to the neuromuscular strength and control in the limb. It requires less time and could be administered easily.

**Barber et al., 1990**

Assessed the functional disabilities in normal and ACL deficient patients and concluded that the three hop tests used for outcome measures were more specific in comparisons of lower limb performance.

**Tegner et al., 1986**

Reported the results of comparison of patients with ACL deficient knee with competitive soccer players using tests like single leg hop tests, figure eight run etc., and concluded that ACL deficient patients were able to control the hopping and straight running.

# III. METHODOLOGY

## 3.1. STUDY DESIGN

Pre-test and post-test experimental study design.

## 3.2. STUDY SETTING

Department of physiotherapy, KG Hospital, Coimbatore.

## 3.3. STUDY SAMPLE

Based on selection criteria, 30 players were selected and they were allotted into 2 groups by simple random sampling method. **N=30**,

**GROUP A** (n=15)

**GROUP B** (n=15)

## Group A - Control group

Subjects received proprioceptive training along with standard ACL rehabilitation.

## Group B – Experimental group

Subjects received cross eccentric quadriceps strength training along with ACL rehabilitation.

## 3.4. STUDY DURATION

The total study was conducted for a period of 6 months and each patient received treatment for a period of 8 weeks, after which follow up was done.

## 3.5. CRITERIA FOR SELECTION

### Inclusion criteria:

- Male collegiate football players.
- Age between 20-30 years.
- Players with Grade II ACL rupture undergone ACL reconstruction with patella tendon bone graft.
- Players with no other previous injuries.
- Players with unilateral ACL Reconstruction.
- Players who are willing to participate in the study.

### Exclusion criteria:

- Players with any other ligament injuries.
- Leg length discrepancy.
- Any pain in the knee joint that was not related to the ACL injury.
- Players with any associated injuries to Hip or Ankle joint.
- Players with any cardiovascular problems.
- Other sports players were excluded.

## 3.6. VARIABLES

### Independent variables:

- Proprioceptive training.
- Cross eccentric strength training.
- Standard ACL rehabilitation.

### Dependent variables:

- Functional Disability.

## 3.7. OPERATIONAL TOOLS

Lysholm knee scale.

Single leg hop test.

## 3.8. PARAMETER

Functional disability.

## 3.9. PROCEDURE

The study was conducted in department of physiotherapy, KG hospital, Coimbatore. 30 subjects, who fulfilled the inclusion and exclusion criteria were recruited and randomized using simple random sampling (lottery) method into 2 groups. All the players were examined by the orthopedician and a senior physiotherapist. A clear explanation was given to every player about the procedures and a written consent was obtained.

**GROUP – A: CONTROL GROUP** (n=15)

Subjects underwent proprioceptive training along with standard ACL rehabilitation.

The treatment began 2 weeks after surgery with:

- Frequency of treatment: 3 days per week for 8 weeks.
- Number of session: 1 session per day.
- Treatment Duration: 30 minutes.
- Standard ACL rehabilitation for 6 months.

**GROUP – B: EXPERIMENTAL GROUP** (n=15)

Subjects underwent cross eccentric quadriceps strength training along with standard ACL rehabilitation.

The treatment began 2 weeks after surgery with:

- Frequency of treatment:  3 days per week for 8 weeks.
- Number of session: 1 session per day
- Treatment Duration: 30 minutes.
- Standard ACL rehabilitation for 6 months.

**ETHICAL APPROVAL**

The study was approved by the ethical committee of KG hospital, coimbatore.

## 3.10. STATISTICAL TOOL USED

Paired ‘t’ - test

The intra group analysis of results were done with paired‘t’ test with 5 % level of significance. Statistical analysis were done using dependent ‘t’ test.





Where,

d= difference between the pre - test versus post - test

d = mean difference

n = number of observations

s = standard deviation

**To compare experimental group and control group**

Statistical analysis is done using independent ‘t’ test



Where,

S = Combined standard deviation

$S_1$ and $S_2$ = Standard deviation of experimental and control group respectively.

$d_1$and $d_2$ = Difference between initial and final readings in control group and experimental group respectively.

$n_1$ =Number of patients in control group

$n_2$ =Number of patients in experimental group

$X_1$ and $X_2$ = Mean of control group and experimental group respectively.

# IV. DATA ANALYSIS AND INTERPRETATION

## LYSHOLM KNEE SCALE

## TABLE - 1

## COMPARISION OF PRE AND POST TEST VALUES OF GROUP-A (CONTROL GROUP)

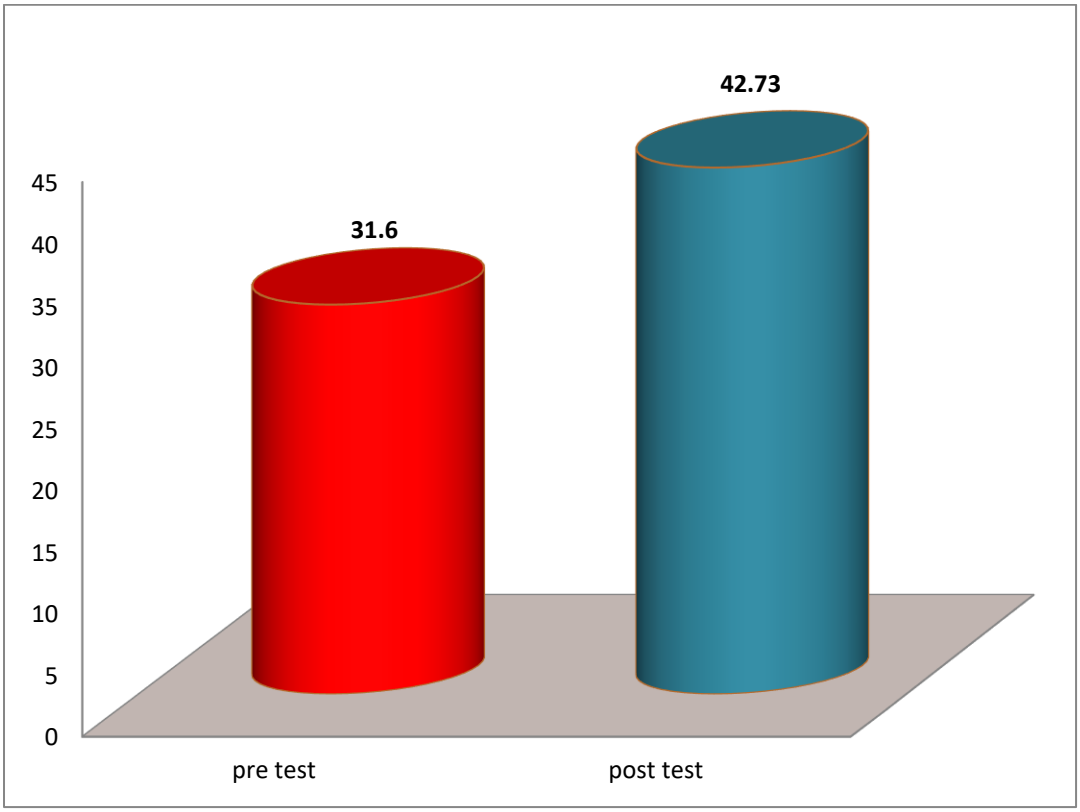
The mean values, mean differences, standard deviation and paired 't' values of lysholm knee scale for group A.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 31.60 | 11.13 | ± 14.95 | 22.43 |
| 2 | Post test | 42.73 | | | |

The comparison of pre test and post test values of lysholm knee scale for Group A showed that the 't' value 22.43 is significantly greater than the tabulated value 2.132 at 5% level of significance. This shows that there is significant improvement in lysholm knee scale and reduction in functional disability following proprioceptive training.

# GRAPH – 1

# COMPARISON OF PRE AND POST TEST MEAN VALUES OF GROUP A (CONTROL GROUP)



# TABLE – 2

## LYSHOLM KNEE SCALE

## PAIRED 't' TEST – PRE AND POST TEST VALUES OF GROUP B (EXPERIMENTAL GROUP)

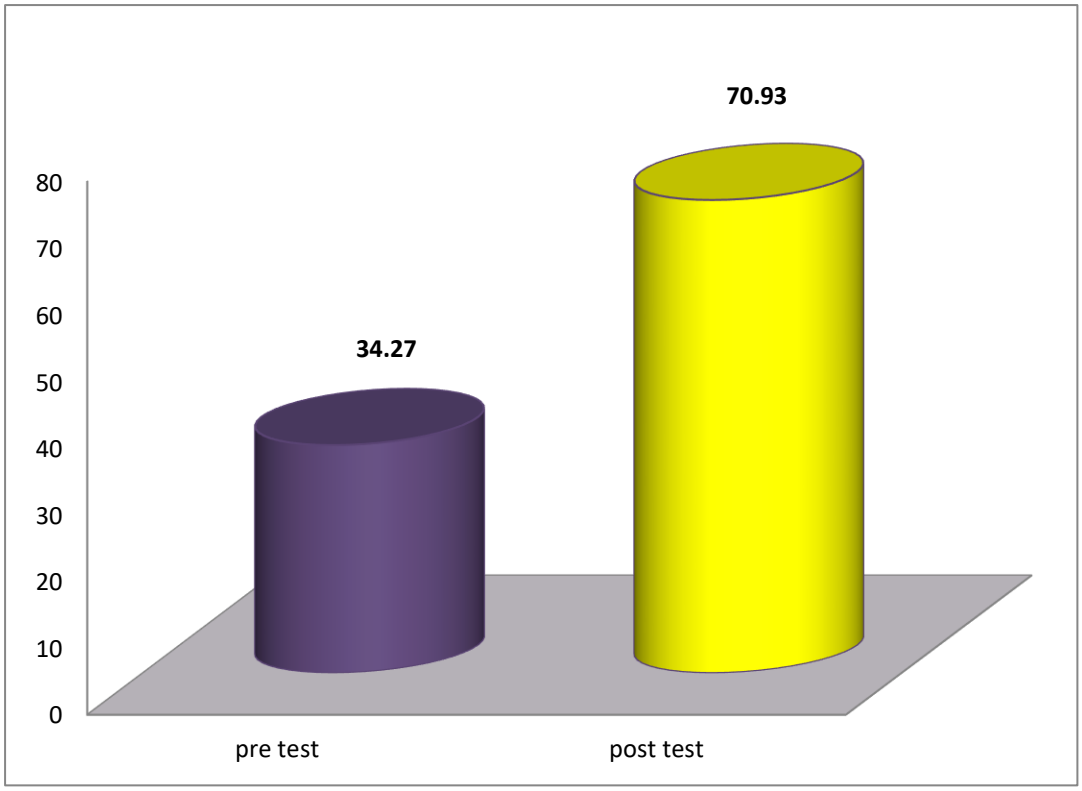
The mean values, mean differences, standard deviation and paired 't' values of lysholm knee scale for Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 34.27 | 36.66 | ± 37.9 | 25.41 |
| 2 | Post test | 70.93 | | | |

The comparison of pre test and post test values of lysholm knee scale for Group B showed that the 't' value 25.41 is significantly greater than the tabulated value 2.132 at 5% level of significance. This shows that there is significant improvement in lysholm knee scale and reduction of functional disability following cross eccentric quadriceps strength training.

# GRAPH – 2

# COMPARISON OF PRE AND POST TEST MEAN VALUES OF GROUP B (EXPERIMENTAL GROUP)



# TABLE – 3

## LYSHOLM KNEE SCALE

## UNPAIRED 't' TEST – PRE TEST VALUES OF GROUP – A AND GROUP – B

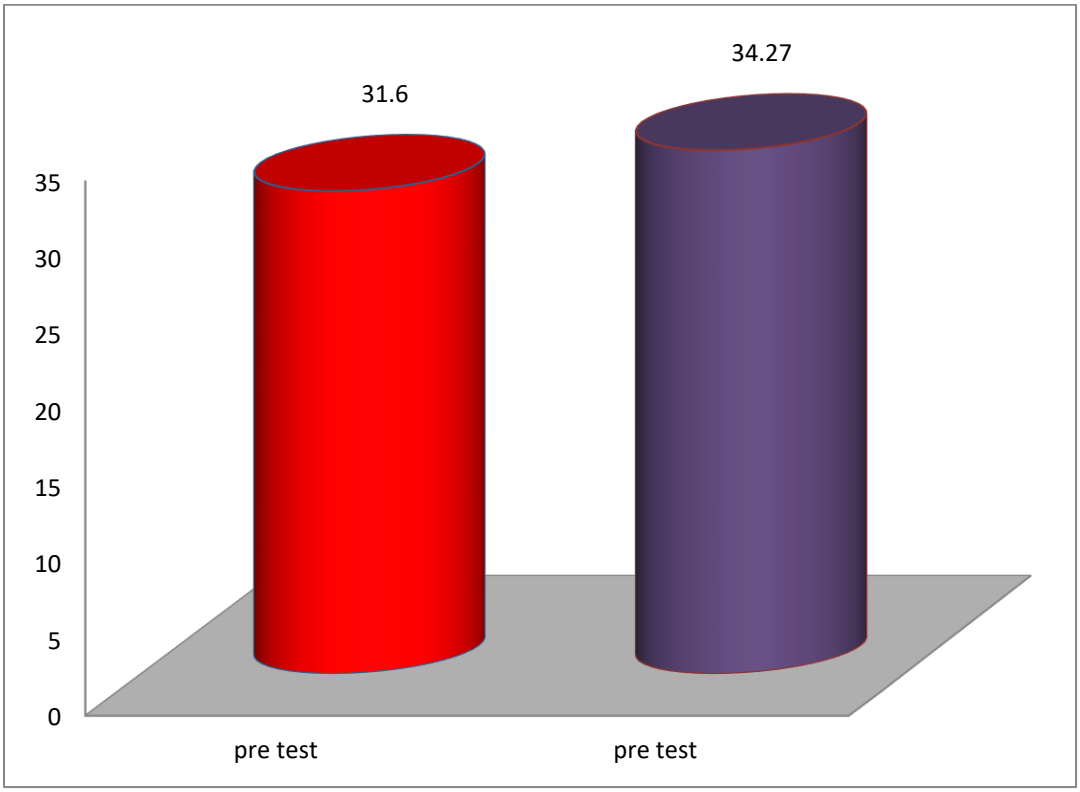
The mean values, mean differences, standard deviation and unpaired 't' values of lysholm knee scale for Group A and Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | UNPAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 31.60 | 2.67 | ± 15.49 | 1.85 |
| 2 | Pre test | 34.27 | | | |

The comparison of pre test values of Group A and Group B showed that the 't' value 1.85 is not greater than the tabulated value 2.048 at 5% level of significance. This shows that there is significant improvement in lysholm knee scale and reduction of functional disability following cross eccentric quadriceps strength training and standard ACL rehabilitation.

# GRAPH 3

# COMPARISON OF PRE TEST MEAN VALUES OF GROUP A AND GROUP B



# TABLE - 4

## LYSHOLM KNEE SCALE

## UNPAIRED 't' TEST – POST TEST VALUES OF GROUP A AND GROUP B

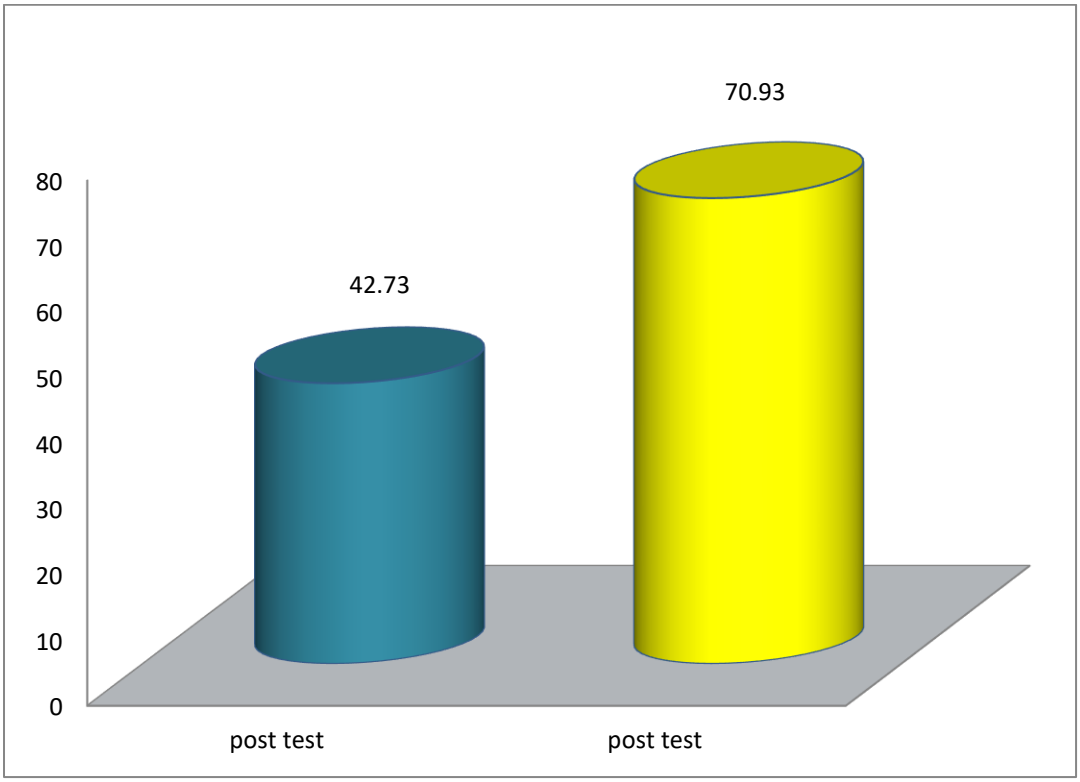
The mean values, mean differences, standard deviation and unpaired 't' test values of lysholm knee scale for Group A and Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | UNPAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Post test | 42.73 | 28.2 | ± 37.36 | 12.64 |
| 2 | Post test | 70.93 | | | |

The comparison of post test values of Group A and Group B showed that the 't' value 12.64 is greater than the tabulated value 2.048 at 5% level of significance. This shows that there is significant improvement in lysholm knee scale and reduction of functional disability following cross eccentric training and standard ACL rehabilitation.

# GRAPH – 4

# COMPARISON OF POST TEST MEAN VALUES OF GROUP A AND GROUP B



# TABLE – 5

# SINGLE LEG HOP TEST

# PAIRED 't' TEST – PRE AND POST TEST VALUES OF GROUP – A

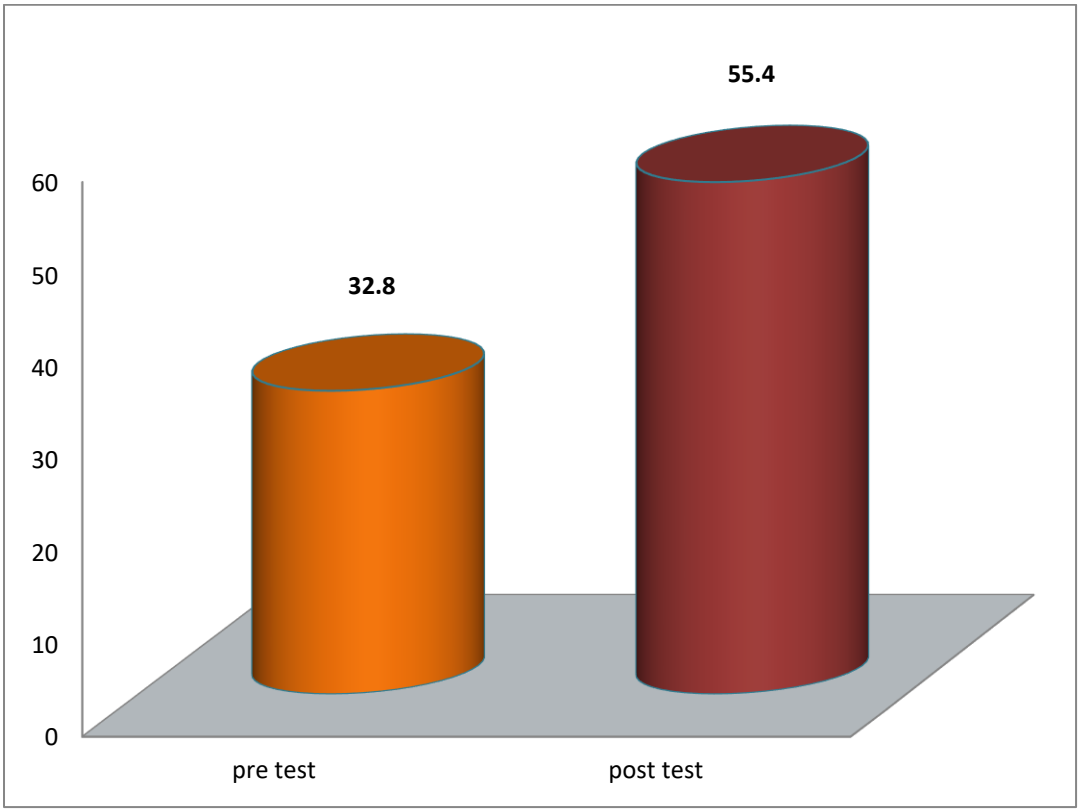
The mean values, mean differences, standard deviation and paired 't' values of single leg hop test for Group A.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 32.80 | 22.60 | ± 29.66 | 20.02 |
| 2 | Post test | 55.40 | | | |

The comparison of pre test and post test values of single leg hop test for Group A showed that the 't value 20.02 is significantly greater than the tabulated value 2.132 at 5% level of significance. This shows that there is significant improvement in single leg hop test and reduction of functional disability following proprioceptive training.

# GRAPH – 5

# COMPARISON OF PRE AND POST TEST MEAN VALUES OF GROUP A (CONTROL GROUP)



# TABLE – 6

## SINGLE LEG HOP TEST

## PAIRED 't' TEST – PRE AND POST TEST VALUES OF GROUP B

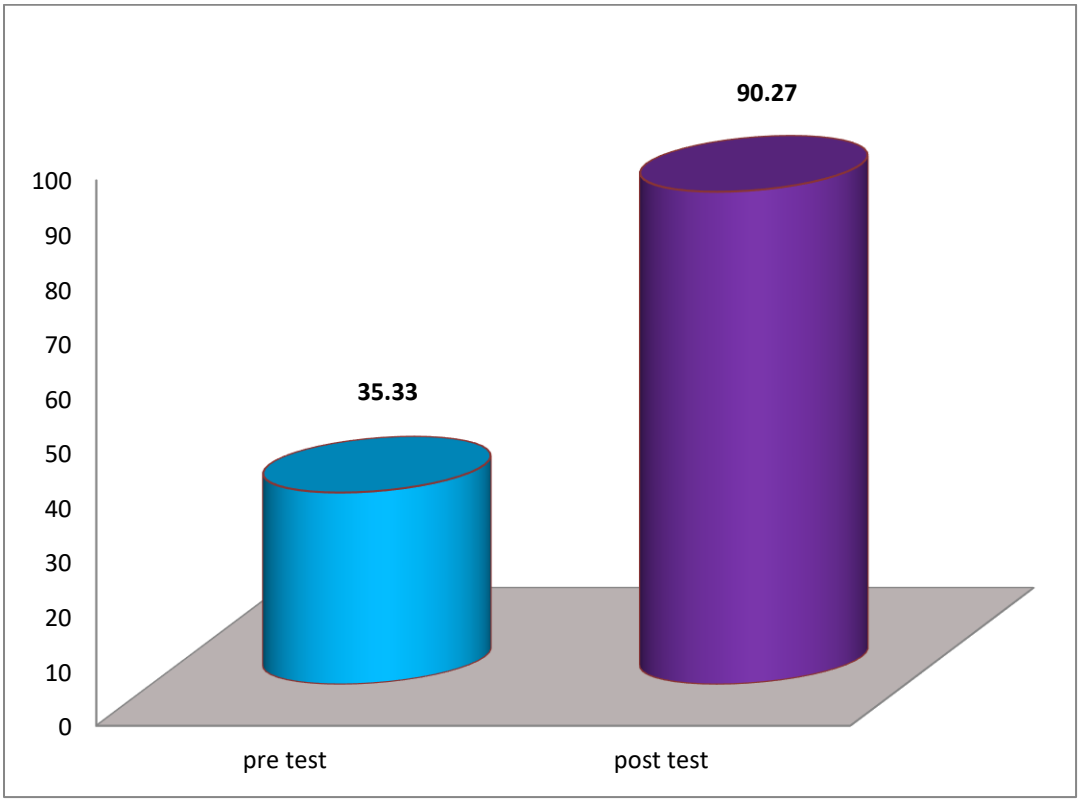
The mean values, mean differences, standard deviation and paired 't' values of single leg hop test for Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED 't' TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 35.33 | 51.94 | ± 27.47 | 25.77 |
| 2 | Post test | 90.27 | | | |

The comparison of pre test and post test values of single leg hop test for Group B showed that the 't' value 25.77 is significantly greater than the tabulated value 2.132 at 5% level of significance. This shows that there is significant improvement in single leg hop test and reduction of functional disability following cross eccentric quadriceps strength training and standard ACL rehabilitation.

# GRAPH 6

# COMPARISON OF PRE AND POST TEST MEAN VALUES OF GROUP B (EXPERIMENTAL GROUP)



# TABLE – 7

# SINGLE LEG HOP TEST

# UNPAIRED ‘t’ TEST- PRE TEST VALUES OF GROUP A AND GROUP B

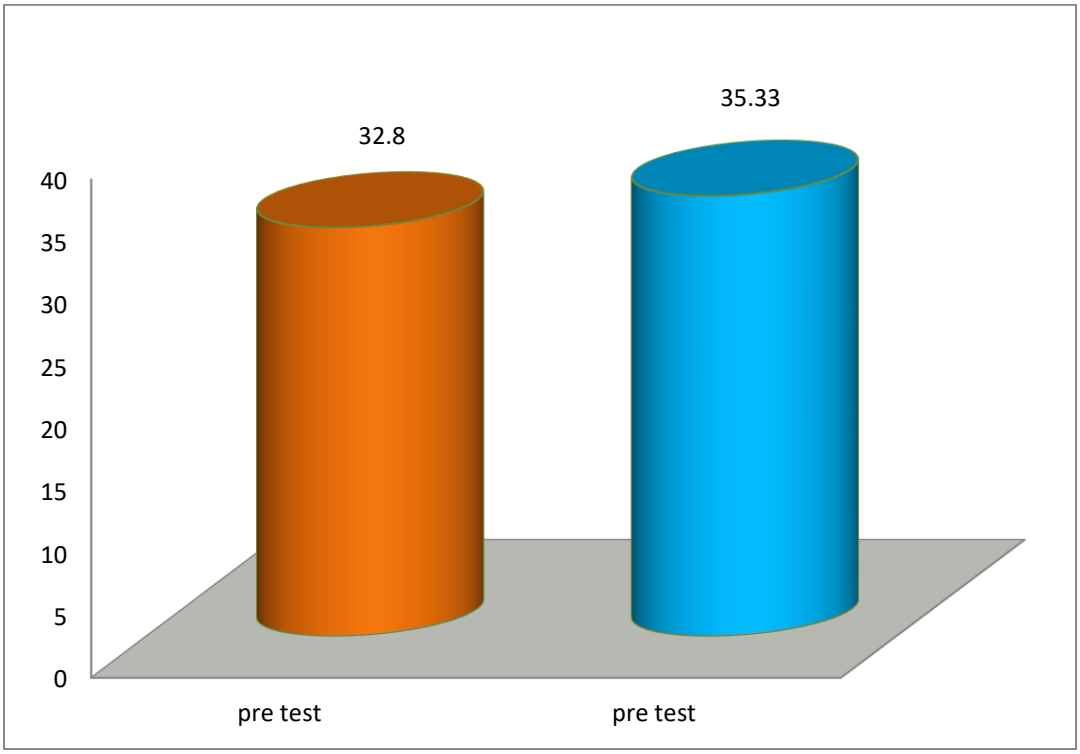
The mean values, mean differences, standard deviation and unpaired “t” values of single leg hop test for Group A and Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED ‘t’ TEST |
|---|---|---|---|---|---|
| 1 | Pre test | 32.80 | 5.53 | ± 27.7 | 2.10 |
| 2 | Pre test | 35.33 | | | |

The comparison of pre test values of Group A and Group B showed that the ‘t’ value 2.10 is not greater than the tabulated value 2.048at 5% level of significance. This shows that there is significant improvement in single leg hop test and reduction of functional disability following cross eccentric quadriceps strength training and standard ACL rehabilitation.

# GRAPH – 7

# COMPARISON OF PRE TEST MEAN VALUES OF GROUP A AND GROUP B



# TABLE -8

## SINGLE LEG HOP TEST

## UNPAIRED ‘t’ TEST- POST TEST VALUES OF GROUP A AND GROUP B

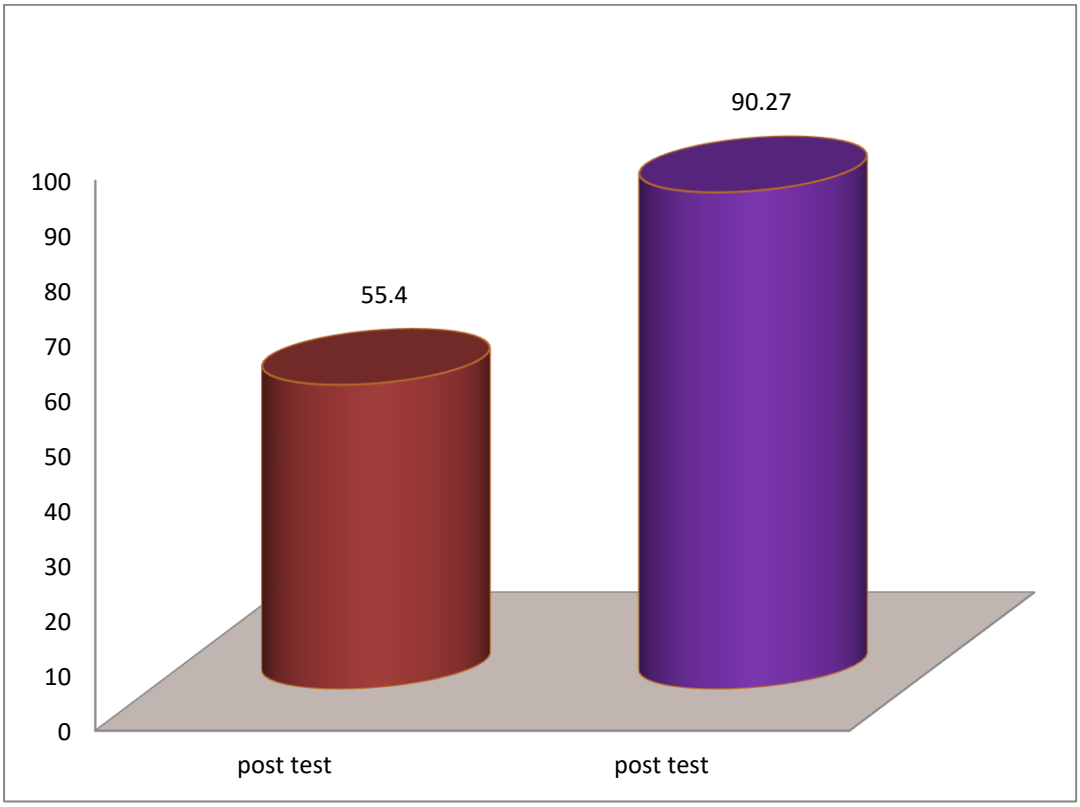
The mean values, mean differences, standard deviation and unpaired ‘t’ values of single leg hop testfor Group A and Group B.

| S.NO | TEST | MEAN | MEAN DIFFERENCE | STANDARD DEVIATION | PAIRED ‘t’ TEST |
|---|---|---|---|---|---|
| 1 | Post test | 55.40 | 34.87 | ± 29.43 | 17.60 |
| 2 | Post test | 90.27 | | | |

The comparison of post test values of Group A and Group B showed that the ‘t’ value 17.60 is greater than the tabulated value 2.048 at 5% level of significance. This shows that there is significant improvement in single leg hop test and reduction of functional disability following cross eccentric quadriceps strength training and standard ACL rehabilitation.

# GRAPH 8

# COMPARISON OF POST TEST MEAN VALUES OF GROUP A AND GROUP B



# V. DISCUSSION

This is an experimental study to analyze the effectiveness of cross eccentric quadriceps strength training on functional disability in collegiate football players with ACL reconstruction.

30 players, who fulfilled the inclusion criteria were recruited and divided into two groups, GROUP – A Control group and GROUP – B Experimental group each consisted of 15 players and the study was conducted in the department of physiotherapy, KG Hospital. GROUP – A received proprioceptive training along with standard ACL rehabilitation and GROUP – B received cross eccentric quadriceps strength training along with the standard ACL rehabilitation. The study was conducted for a period of 8 weeks that involved one session per day for 3 days in a week for duration of 30 minutes.

The results obtained from the statistical analysis between the pre-test and post-test values of experimental group at 5% level of significance showed significant improvement in the Lysholm knee scale and single leg hop test following cross eccentric quadriceps strength training along with standard ACL rehabilitation – hence this permits the rejection of null hypothesis. Analysis of pre test and post test values of control group at 5% level of significance showed significant improvement following proprioceptive training alone. Analysis of pre test means of experimental and control group reveals that there is significance difference between the two groups indicating that they are

unmatched groups of subjects undergoing different exercise program but were selected from the same population.

Analysis of result also shows that there is an increase in experimental group when compared with the control group that has less increase in the outcome measure of lysholm knee scale. Results obtained in single leg hop test also shows that there is increase in the experimental group when compared with the increase in the control group. This shows the superiority of cross eccentric quadriceps strength training along with standard ACL rehabilitation given to experimental group than that of proprioceptive training along with standard ACL rehabilitation given to control group.

A beneficial effect in the untrained limb can be achieved by training the uninjured limb, by the inter-limb interaction and hence suggested in rehabilitation for patients, suffering from conditions that prevent them exercising the injured limb **(ZHOU et al., 2000).** Most studies in the past had proved the beneficial effects of including eccentric exercise in the cross exercise training for improving quadriceps strength compared with concentric or isometric contractions **(AAGARD et al., 2000).** In the past no other studies had reported about the frequency in cross exercise for improving quadriceps strength. However only one study had analyzed the effect of frequency of training and implicated that 3 days per week of cross eccentric exercise to be beneficial on comparison with 5 days per week frequency **(Maria G.**

**Papandreou et al.,2007).**Cross exercise is based on the theory of the cerebral cortex, states that the voluntary contraction of the trained muscle produces a facilitatory effect of the same motor point on the opposite side of the cerebral cortex, thereby activating the contralateral muscle **(Carr et al., 1994).**

Proprioceptive exercises when performed at specific angles, the joint mechanoreceptors gets activated. In the intermediate range there is more activation of the muscle receptors, were as both the joint and muscle receptors play a major role in the end range of motions **(Lattanzio PJ et al., 1998).**

The correlation between latency and functional instability (frequency of giving way) in patients with ACL deficiency insinuates that this function could play a protective role. Evidence that the reflex hamstring contraction latency time can be reduced by performing proprioceptive exercises with the aim of improving speed and facility of hamstring contractions further supports the principles of injury prevention training **(Beard DJ et al., 1993).**

Thus it can be concluded that cross eccentric quadriceps strength training exercise along with the standard ACL rehabilitation could play a major role in reduction of the functional disability in collegiate football players with ACL reconstructions.

# VI. SUMMARY AND CONCLUSION

This study analyzes the effectiveness of cross eccentric quadriceps strength training on functional disability in collegiate football players with ACL reconstruction. In the thirty players with ACL reconstructed knee, the functional disability was tested by lysholm knee scale and single leg hop test. They were divided into control and experimental group, with 15 players in each group.

Experimental group players were given cross eccentric quadriceps strength training along with standard ACL rehabilitation and control group were given proprioceptive training along with standard ACL rehabilitation. The duration was 8 weeks after which follow up were done for 6 months. 2 weeks after ACL reconstruction the functional disability was measured using lysholm knee scale and single leg hop test. At the end of the treatment on 11th week functional disability was checked again. The results were analyzed by using student ‘t’ test.

It showed that cross eccentric quadriceps strength training along with standard ACL rehabilitation given to the experimental group proved to be superior than proprioceptive training along with standard ACL rehabilitation, which is given to the control group.

The analysis of results showed that following cross eccentric quadriceps strength training along with standard ACL rehabilitation reduced functional disability in players with ACL reconstruction. Cross eccentric exercise has beneficial and long term effects on the quadriceps strengthening in the early phase of ACL rehabilitation, when a player is unable to do exercise in the ACL reconstructed knee. The risks are also very minimal and early return to sporting activities can be achieved.

# VII. LIMITATIONS AND RECOMMENDATIONS

## LIMITATIONS

- Small number of samples.
- Study included only collegiate football players.
- Study does not focus on dominant and non-dominant limbs.
- Only male players were included.

## RECOMMENDATIONS

- Future study should be made on large sample size, with long term follow ups.
- Future research should be focused on others sports also.
- Future research should focus on effect of different frequencies of cross eccentric exercise.

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# IX. APPENDIX

## APPENDIX - I

## ASSESSMENT FORMAT

- **Subjective Examination:-**

**a) Name :**

**b) Age : Yrs**

**c) Sex : □ M □ F**

**d) Occupation :**

**e) Chief complaints :**

| | |
|---|---|
| Dislocation of knee Joint | Yes /No |
| Hyper mobility | Yes/ No |
| Recent fracture around the knee | Yes/ No |
| Neurological disorders | Yes/ No |
| Hypomobility | Yes/ No |

- **Weight : kgs**
- **Height : cms**

**(ii) History collection:-**

- **Present Medical history**

  Any fracture or dislocation of **knee joint** - Yes/No

- **Past Medical history:-**

  Fracture complication of the **knee joint** - Yes/No

**(iii) OBJECTIVE EXAMINATION:**

**On observation:**

- General body built -
- Musculature -
- Deformity -
- Tropic changes -
- External appliances -

**On palpation:**

- Temperature -
- Swelling -
- Bony prominence -
- Local tenderness -
- Oedema or effusion -
- Scar tissue -
- Muscle spasm -

**on examination:**

**PAIN ASSESSMENT (USING VAS)**

- On set -
- Duration -
- Site of pain -
- Type of pain -
- Nature of pain -
- Aggrevating factors -
- Relieving factors -

**USING VAS**

---

**0** **10**

No Pain Maximum

**SENSORY EXAMINATION:**

- Temperature
- Pressure

**MOTOR EXAMINATION:**

Muscle power assessment

Joint range of motion

**DIAGNOSIS**

- X – Ray
- Medical Imaging
- **Special Tests**
    - **Anterior drawer test** □ **+ ve** □ **- ve**
    - **Lachman test** □ **+ ve** □ **- ve**
    - **Mc Murrray's test** □ **+ ve** □ **- ve**

- AIMS :
- Means :
- Home Program :

# APPENDIX - II

# ACL REHABILITATION TRAINING

| **Post-operative phase** | **Rehabilitation protocol** |
|---|---|
| Phase 1<br>Duration 2-4 weeks | ➢ Immediate straight leg raise.<br>➢ Early range of motion exercise with an emphasis on gaining full knee extension.<br>➢ Weight bearing full as tolerated.<br>➢ First week 70 degree of flexion.<br>➢ Static squat (90 degree flexion). |
| Phase 2<br>Duration 2-3 months | ➢ Endurance training(biking)<br>➢ Progressive resistance training (leg press, calf press, step up).<br>➢ Dynamic squat (0-110 degree).<br>➢ Balance exercises.<br>➢ Beginning level plyometric exercises.<br>➢ Progressive resistance exercises full range of motion, hop on one leg without pain.<br>➢ Isokinetic exercises and assessment. |

| | |
|---|---|
| Phase 3<br><br>Duration 3-6 months | ➢ Continue progressive resistance and endurance training.<br>➢ Jogging/ running swimming.<br>➢ Advanced plyometric exercises.<br>➢ Strengthening and functional exercises training to prepare the individual for full return activity.<br>➢ Goals for returning to full activity; 80% strength and 85% functional ability and proprioception > 90% compared to the difference >70%, |
| Functional brace | ➢ 6 weeks. |


**SQUATTING**


**SINGLE LEG STANCE**

**STATIC CYCLING**

# APPENDIX - III

# CROSS ECCENTRIC QUADRICEPS STRENGTH TRAINING

In order to assess the quadriceps strength on uninjured knee, it was determined by the one repetition maximum (1RM) in eccentric contraction on the Quads table.

The resistance was provided by a lever arm which was placed just above the medial malleolus. The weight of determination of 1-RM eccentric strength involved a trial in which progressively heavier loads were applied until the subject was unable to satisfactory completed the repetition. The eccentric exercise program consisted of two to three warm up sets with no loads and followed by five sets of six repetitions at 80% of 1RM of eccentric training intensity quadriceps strength.

The intensity kept constant throughout the eight weeks period. Two minutes of rest was allowed between each set. The subjects performed each eccentric contraction by lifting the load to the starting position with one leg-the uninjured one. Each subject had to control the load and then gently release it at his own speed.

# CROSS ECCENTRIC TRAINING


## STARTING POSITION


## END POSITION

# APPENDIX - IV

# PROPRIOCEPTIVE TRAINING

The proprioceptive training consisted of:

## Athletic stance balance

Stand on the board with knees bent slightly, feet shoulder width apart and trunk erect. Maintain this position while balancing the board, trying to keep either side touching the ground.

## Front to back stance

Stand in a staggered stance with one knee near front of the board and one foot near the back of the board. Maintain athletic position while balancing the board, trying to keep either side from touching the ground.

## Single leg balance

Stand on one leg in the center of the board, trying to keep either side from touching the ground while maintain erect posture.

# APPENDIX - V

# LYSHOLM KNEE SCALE

## I. LIMP:

- I have no limp when I walk. (5)
- I have a slight or periodical limp when I walk. (3)
- I have a severe and constant limp when I walk. (0)

## II. USING CANE OR CRUTCHES

- I do not use a cane or crutches. (5)
- I use a cane or crutches with some weight-bearing. (2)
- Putting weight on my hurt leg is impossible. (0)

## III. LOCKING SENSATION IN THE KNEE

- I have no locking and no catching sensations in my knee. (15)
- I have catching sensation but no locking sensation in my knee. (10)
- My knee locks occasionally. (6)
- My knee locks frequently. (2)
- My knee feels locked at this moment. (0)

## IV. GIVING WAY SENSATION FROM THE KNEE

- My knee never gives way. (25)
- My knee rarely gives way, only during athletics orother vigorous activities. (20)
- My knee frequently gives way during athletics or other vigorous activities, in turn I am unable to participate in these activities. (15)
- My knee occasionally gives way during daily activities. (10)
- My knee often gives way during daily activities. (5)
- My knee gives way every step I take. (0)

## V. PAIN:

- I have no pain in my knee. (25)
- I have intermittent or slight pain in my knee during vigorous activities. (20)
- I have marked pain in my knee during vigorous activities. (15)
- I have marked pain in my knee during or after walking more than 1 mile. (10)
- I have marked pain in my knee during or after walking less than 1 mile. (5)
- I have constant pain in my knee. (0)

**VI. SWELLING**

- I have no swelling in my knee. (10)
- I have swelling in my knee only after vigorous activities. (6)
- I have swelling in my knee after ordinary activities. (2)
- I have swelling constantly in my knee. (0)

**VII. CLIMBING STAIRS:**

- I have no problems climbing stairs. (10)
- I have slight problems climbing stairs. (6)
- I can climb stairs only one at a time. (2)
- Climbing stairs is impossible for me. (0)

**VIII. SQUATTING**

- I have no problems squatting. (5)
- I have slight problems squatting. (4)
- I cannot squat beyond a 90 degree bend in my knee. (2)
- Squatting is impossible because of my knee. (0)

**TOTAL_____/100**

# APPENDIX VI

# SINGLE LEG HOP TEST

**Single leg hop:**

For single leg hopping, stand on one foot with your toes behind a line marked on the floor.

Hop forward as far as possible, landing on the same foot from which you took off. Measure and record the distance you hopped in centimeters (cm).

Repeat the test, recording the distance hopped each time for each player.


**STARTING POSITION**

**HOPPING**

**MARKING**

# APPENDIX VII

## PATIENT CONSENT FORM

I ……voluntarily consent to participate in the project named **"AN EXPERIMENTAL STUDY TO ANALYZE THE EFFECTIVENESS OF CROSS ECCENTRIC QUADRICEPS STRENGTH TRAINING ON FUNCTIONAL DISABILITY IN FOOTBALL PLAYERS WITH ACL RECONSTRUCTION"**

The candidate has explained to me that treatment approach in brief, risk of participation and has answered the questions related to the study to my satisfaction.

Participant's Signature :

Signature of witness :

Signature of candidate :

Date :